

New odorant compounds

This invention relates to novel compounds having woody, vetiver and patchouli-like odour notes. This invention relates furthermore to a method for their production and to 5 flavour and fragrance compositions containing them.

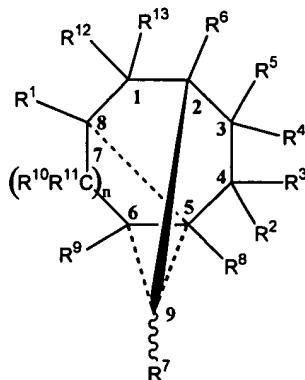
Compounds having woody, vetiver and patchouli-like odour notes are described in the literature, for example the class of sesquiterpenes that naturally occur in essential oils and which can be isolated by water-steam distillation of a plant or parts of a plant. This 10 process is very cost intensive and the quality and the odour as well as the flavour characteristics of the isolated compounds may vary with the climate and the origin of the plant. Thus, there is an ongoing demand in the fragrance and flavour industry for new compounds imparting, enhancing, or improving woody, vetiver and patchouli-like notes.

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Tricyclic sesquiterpenes, in particular patchoulol and derivatives thereof have been disclosed in the U.S. Patent No. 4,011,269. The compounds described therein develop odoriferous notes the character of which is reminiscent of that of patchouli oil.

20 We have now found a novel class of compounds having much sought after woody, vetiver and patchouli-like odour notes and which may be produced from synthetic starting materials.

In a first aspect the invention provides a compound of the formula I



25

wherein

R¹, R⁴, R⁶ and R⁷ are independently hydrogen, methyl or ethyl;

R^2 and R^3 are independently hydrogen, or C_{1-5} alkyl, e.g. methyl, ethyl, or linear or branched propyl, butyl, or pentyl; or

R^2 and R^3 together with the carbon atom to which they are attached form a 5- or 6-membered cycloalkyl ring;

5 R^5 is hydrogen, or C_{1-4} alkyl, e.g. methyl, ethyl or linear or branched propyl;

R^8 is hydrogen, or branched lower C_{3-7} alkyl, e.g. isopropyl, tert. butyl;

R^9 is hydrogen, methyl, ethyl, or branched lower C_{3-7} alkyl, e.g. isopropyl, tert. butyl;

R^{10} is ethyl or propyl;

R^{11} is C_{1-4} alkyl, e.g. methyl, ethyl, or linear or branched propyl or butyl;

10 R^{12} is hydroxy;

R^{13} is hydrogen, or C_{1-4} alkyl, e.g. methyl ethyl, or linear or branched propyl or butyl; or

R^{12} and R^{13} together with the carbon atom to which they are attached form a carbonyl group;

the dashed line represents either a C-C single bond or no bond; and

15

a) when C5 and C8 are connected by single bond and C9 and C6 are connected by a single bond, C9 and C5 are not connected by a bond,

$n=1$,

R^7 , R^8 are hydrogen, and

20 R^9 is hydrogen, methyl or ethyl; or

b) when C5 and C8 are connected by a single bond and C9 and C6 are connected by a single bond, C9 and C5 are not connected,

$n=0$,

25 R^7 , R^8 is hydrogen,

R^9 is a branched lower C_{3-7} alkyl; or

c) when C5 and C8 are not connected by a bond, C9 and C5 are connected by a single bond,

30 R^7 is hydrogen, methyl or ethyl,

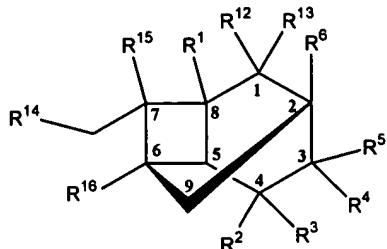
R^8 is a branched lower C_{3-7} alkyl, or

R^7 and R^8 together with the carbon atoms to which they are attached form a 5- or 6-membered cycloalkyl ring,

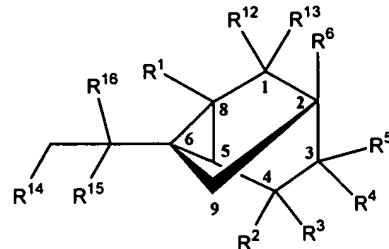
$n = 0$, and

35 the bond between C6 and C8 may be a single bond or a double bond.

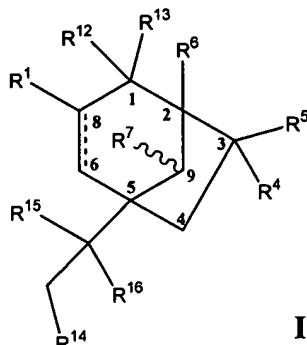
Preferred compounds are those of the formulae Ia, Ib and Ic



Ia



Ib



Ic

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wherein

- R^1, R^4, R^6 , and R^{16} are independently hydrogen, methyl or ethyl;
- R^7 and R^{14} are independently hydrogen, methyl or ethyl; or,
- 10 R^7 and R^{14} together with the carbon atoms to which they are attached form a 5- or 6-membered cycloalkyl ring;
- R^2 and R^3 are independently hydrogen, or C_{1-5} alkyl, e.g. methyl, ethyl, or linear or branched propyl, butyl, or pentyl; or,
- 15 R^2 and R^3 together with the carbon atom to which they are attached form a 5- or 6-membered cycloalkyl ring;
- R^5 is hydrogen, or C_{1-4} alkyl, e.g. methyl, ethyl, or linear or branched propyl;
- R^{15} is C_{1-4} alkyl, e.g. methyl, ethyl, or linear or branched propyl;
- R^{12} is hydroxy;
- R^{13} is hydrogen or C_{1-4} alkyl, e.g. methyl, ethyl, or linear or branched propyl; or
- 20 R^{12} and R^{13} together with the carbon atom to which they are attached form a carbonyl group; and

in formula Ic the bond between C6 and C8 may be a single bond, or the dotted line together with the bond between C6 and C8 may represent a double bond .

The compounds according to the present invention contain one or more chiral centres and as such may exist as a mixture of stereoisomers, or they may be resolved as isomerically pure forms. Resolving stereoisomers adds to the complexity of manufacture and purification of these compounds and so it is preferred to use the

5 compounds as mixtures of their stereoisomers simply for economic reasons. However, if it is desired to prepare individual stereoisomers, this may be achieved according to methodology known in the art, e.g. preparative HPLC and GC or by stereoselective syntheses.

10 Particular preferred compounds of formula Ia are 1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, 1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, 1,3,3,5,7,8,8-Heptamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, 3,3,5,7,8,8-Hexamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, 3,3,5,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, 5,7,8,8-Tetramethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one, and 5,6,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-ol.

15

A particular preferred compound of formula Ib is 1-Isopropyl-3,3,5-trimethyl-tricyclo[3.2.1.0^{2,7}]octan-6-one.

20 Particular preferred compounds of formula Ic are 5-Isopropyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one, 5-Isopropyl-1,3-dimethyl-bicyclo[3.2.1]octan-2-one, 5-tert-Butyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one, 5-sec-Butyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-ene-2-one, 5-Isopropyl-3-methyl-bicyclo[3.2.1]oct-3-en-2-one, 5-Isopropyl-3,7,7-trimethyl-bicyclo[3.2.1]oct-3-en-2-one, and 1,3,5-Trimethyl-1,5,6,7,8,8a-hexahydro-1,4a-ethano-naphthalen-2-one.

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In another aspect the invention provides flavour and fragrance compositions comprising a compound of formula I or mixtures thereof, more particularly compounds of formula

30 Ia, Ib, or Ic or mixtures thereof. Particular preferred are compositions that comprise at least one compound of formula Ia and one compound of formula Ic.

In addition, the compounds may be used in combination with a basis material. As used herein, the "basis material" includes all known odourant molecules selected from the

35 extensive range of natural and synthetic molecules currently available, such as

essential oil, alcohols, aldehydes and ketones, ether and acetals, ester and lactones, macrocycles and heterocycles, and/or in admixture with one or more ingredients or excipients conventionally used in conjunction with odourants in fragrance compositions, for example carrier materials, and other auxiliary agents commonly used in the art.

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In one embodiment, the compounds of the present invention may be used in fragrance applications, e.g. in any field of fine and functionary perfumery.

10 In another embodiment, the compounds of the present invention may be used in flavour applications and are particularly useful in modifying for example strawberry and raspberry flavours but also brown flavours. They may be used in herbal mixtures and teas. The compounds of the present invention are also well suited for example in mouthwash applications.

15 In flavourant applications, the compounds of the present invention may be present in compositions in amounts ranging from 0.001 to 5 % by weight of a flavour composition, more preferably from 0.01 to 0.5 % by weight. The compounds according to the present invention may be used for herbal flavour compositions, strawberry and raspberry compositions, brown flavour compositions, or tea compositions.

20

When used in fragrance applications, compounds of the present invention can be employed in wide ranging amounts depending upon the specific application and on the nature and quantity of other odourant ingredients, that may be for example, from about 0.001 to about 20 weight percent. In one embodiment compounds may be employed in a fabric softener comprising in amount of about 0.001 to 0.05 weight percent. In another embodiment compounds of the present invention may be in alcoholic solution in amounts of about 0.1 to 20 weight percent, more preferably between about 0.1 and 5 weight percent.

30 However, these values should not be limiting on the present invention, since the experienced perfumer and flavourist may also achieve effects or may create novel accords with lower or higher concentrations.

35 The compounds of the present invention may be employed into the fragrance application simply by directly mixing the fragrance composition with the fragrance

application, or they may, in an earlier step be entrapped with an entrapment material, for example, polymers, capsules, microcapsules and nanocapsules, liposomes, film formers, absorbents such as carbon or zeolites, cyclic oligosaccharides and mixtures thereof, or they may be chemically bonded to substrates, which are adapted to release 5 the fragrance molecule upon application of an external stimulus such as light, enzyme, or the like, and then mixed with the application.

Thus, the invention additionally provides a method of manufacturing a fragrance application, comprising the incorporation of a compound of formula I as a fragrance 10 ingredient, either by directly admixing the compound of formula I to the application or by admixing a fragrance composition comprising a compound of formula I, which may then be mixed to a fragrance application, using conventional techniques and methods.

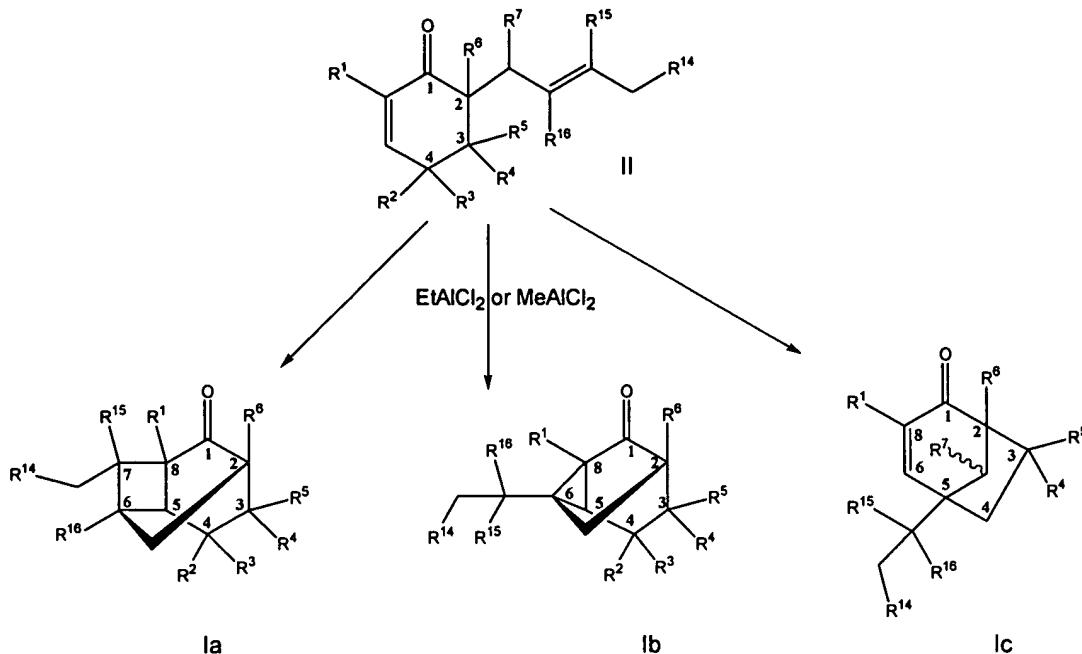
As used herein, "fragrance application" means any product, such as fine perfumery, 15 e.g. perfume and Eau de Toilette; household products, e.g. detergents for dishwasher, surface cleaner; laundry products, e.g. softener, bleach, detergent; body care products, e.g. shampoo, shower gel; and cosmetics, e.g. deodorant, vanishing creme, comprising an odourant. This list of products is given by way of illustration and is not to be regarded as being in any way limiting.

20 The compounds according to the present invention may be prepared according to a process wherein appropriately substituted cyclohexenones are reacted with allyl bromide or allyl chloride under reaction conditions well known to the person skilled in the art (Bull. Chem. Soc. Jpn., 2298 – 2303 (1993). The resulting alkylated 25 cyclohexenones (formula II as shown below) may be converted in the presence of ethyl aluminium-dichloride or methyl aluminium-dichloride to provide compounds of formula I wherein R¹² and R¹³ taken together represents an oxygen atom, as illustrated by compounds of formula Ia, Ib, and Ic in scheme 1. The conditions under which such Lewis acid catalyzed reactions may proceed is described for example by Snider et al. in 30 the Journal of Am. Chem. Soc. 1980, 102, 5872 – 5880 which is herein incorporated by reference.

The resulting carbonyl group at C1 may be reduced and/or alkylated to give further compounds of formula I. Similarly, if there is a double bond at C6 and C8 this can be reduced in a known manner to give still further compounds of formula I.

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Scheme 1:



Compounds of formula II may also be prepared by alkylation of appropriately substituted phenols by reaction of the phenol with a metal hydride and an alkenylchloride (Greuter, H. et al. (1977) *Helv. Chim. Acta*, 60, 1701), followed by hydrogenation.

Whether a compound of formula Ia, Ib, Ic, or a mixture thereof is formed depends on the substituent pattern R^2 , R^3 , and R^{16} of the alkylated cyclohexenone (II). A compound of formula Ic is formed as a main product if R^2 , R^3 , and R^{16} of formula II are hydrogen. A mixture of compounds of formula Ia and Ib as main product is performed if R^2 and R^3 of formula II at the same time are not hydrogen. A mixture of compounds of formula Ia and Ic as main product is formed if R^2 and R^3 of formula II are hydrogen and R^{16} of formula II is not hydrogen. The compounds are useful in flavour and/or fragrance compositions as mixtures, however, should one wish to use the compounds in pure form, they can be separated easily by purification processes, such as HPLC or preparative GC, according to the methodology known in the art.

The term "main product", as used herein with reference to single compounds, refers to a product comprising at least 50% by weight of that compound, more preferably more than 75% by weight, most preferably more than 90% by weight. When this term is used in relation to a mixture of compounds, e.g. one compound of formula Ia and one compound of formula Ic, it refers to a product comprising at least 50% by weight of this

mixture, more particular more than 75% by weight, most particular more than 90% by weight.

The conversion of compounds of formula II for a selective preparation of compounds of formula Ia of the present invention may also be performed by photochemical induction. Surprisingly we found that compounds of formula Ia may be formed by photochemically induced intramolecular [2+2] cycloaddition of compounds of formula II. For the photochemical induction a Hg-lamp may be used for a time period of about 1 to 15 hours. However, the induction time may depend on the solvent used and on additives such as sensitizers and Lewis acids. Preferred solvents are methanol, ethanol and isopropanol.

Thus, in another aspect the invention refers to a method of preparing compounds of formula Ia by photochemically induced cycloaddition.

15

Further particulars as to reaction conditions are provided in the examples.

There now follows a series of examples that illustrate the invention.

20 Example 1:

a) 2-Methyl-6-(3-methyl-but-2-enyl)-cyclohex-2-enone

To a solution of LDA (prepared from BuLi, 1.6 M in hexane, 75 ml, 0.12mol and diisopropylamine, 12.2g, 0.12mol) in THF (50ml) was added 2-methyl-cyclohex-2-enone (11.0g, 0.1mol) at -78°C. The mixture was stirred for 1h at -78°C and prenyl bromide (17.88g, 0.12mol) was added. The mixture was stirred over night, while the temperature was allowed to rise to room temperature. MTBE (50 ml) and sat. NH₄Cl were added, the organic phase was separated and washed with brine, dried (MgSO₄) and concentrated in vacuo. The residue was distilled in a Kugelrohr oven to yield 9.8g (55%) of a slightly yellow oil.

30 ¹H-NMR (400 MHz, CDCl₃): 6.82 (bs, 1H), 5.14-5.09 (m, 1H), 2.56-2.48 (m, 1H), 2.37-2.25 (m, 3H), 2.13-2.03 (m, 2H), 1.77 (s, 3H), 1.70 (s, 3H), 1.75-1.68 (m, 1H), 1.61 (s, 3H) ppm. ¹³C-NMR (100MHz, CDCl₃): 201.6 (s), 144.3 (d), 135.1 (s), 133.0 (s), 121.8 (d), 46.9 (d), 27.8 (t), 27.7 (t), 25.7 (q), 25.0 (t), 17.6 (q), 16.0 (q) ppm. GC/MS (EI): 178 (M⁺, 30), 168 (25), 123 (37), 110 (100), 95 (63), 83 (33), 69 (26), 53 (34), 41 (71), 39 (44). IR (ATR): 2966s, 2924s, 1672vs, 1451s, 1377s, 1181m, 1088m, 836m cm⁻¹.

b) 2,6-dimethyl-6-(3-methyl-but-2-enyl)-cyclohex-2-enone

Sodium hydride (60%, 85 g, 2.13 mol) was added portionwise to a solution of 2,6-dimethylphenol (250g, 2.05 mol) in 2L of toluene at 10-15°C. The resulting suspension was stirred for 45 min. The mixture was cooled to 5°C, and prenyl chloride (262g, 2.13 mol, 85%) was added during 1.5 h keeping the temperature at 5°C. The mixture was then stirred for further 2h at 10-15°C. Methanol (1L) and palladium (2.5g, 10% on charcoal) was added and the gray suspension was hydrogenated at 0.3 bar overpressure, keeping the temperature at 20-22°C (ice bath). The suspension was then filtered through a pad of celite. The yellow filtrate was washed with water (0.5L), aqueous sodium hydroxide (0.5L) and brine (0.5L), dried (MgSO_4) and concentrated *in vacuo*. The residue was distilled over a 5cm Vigreux column to yield 318g (81%, bp 78-82°C/0.05Torr) of a colorless oil.

Odor description: fruity, grapefruit, minty, bergamot

¹⁵ $^1\text{H-NMR}$ (400MHz, CDCl_3): 6.62 (bs, 1H, 3-H), 5.06-5.11 (m, 1H, 2'-H), 2.34-2.28 (m, 2H, 4-H), 2.25-2.14 (m, 2H, 1'H), 1.91 (dt, $J_{5a,5b} = 13.6$ Hz, $J_{5a,4} = 6.1$ Hz, 1H, 5a-H), 1.76 (s, 3H, 2-CH₃), 1.77-1.70 (m, 1H, 5b-H), 1.70 (s, 3H, 4'-H), 1.59 (s, 3H, 3'-CH₃), 1.05 (s, 3H, 6-CH₃) ppm. GC/MS (EI): 192 (M^+ , 16), 124 (100), 109 (74), 82 (31), 69 (40), 41 (57). IR (ATR): 2965s, 2922s, 1667vs, 1449m, 1376m, 1033m cm^{-1} .

20

Example 2: 5-Isopropyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one

To a solution of 2,6-dimethyl-6-(3-methyl-but-2-enyl)-cyclohex-2-enone (5.00 g, 26.04 mmol) in toluene (40 ml) was added dropwise neat EtAlCl_2 (97%, 1.5 eq., 4.96 g, 39.06 mmol). During the addition, the temperature was kept below 10°C. The brown mixture was kept at room temperature over night and was then poured on icecold saturated NH_4Cl . The mixture was extracted with MTBE, washed with brine, dried (MgSO_4) and concentrated *in vacuo*. The residue was distilled bulb to bulb to yield 4.50 g (90%) of an colorless oil.

Odor description: woody, patchouli, vetiver, hesperidic

³⁰ $^1\text{H-NMR}$ (400MHz, CDCl_3): 6.86 (bs, 1H, 4-H), 1.81 (dt, $J = 11.0, 2.2$ Hz, 1H, 8-H_a), 1.78-1.72 (m, 2H, 6-H_a, 7-H_a), 1.75 (d, $J = 1.6$ Hz, 3-CH₃), 1.69 (sept, $J = 6.8$ Hz, 1H, 5-CH(CH₃)₂), 1.64-1.53 (m, 2H, 6-H_b, 7-H_b), 1.37 (dd, $J = 11.0, 2.2$ Hz, 1H, 8-H_b), 1.24 (s, 3H, 1-CH₃), 1.00 (d, $J = 6.8$ Hz, 3H, 5-CH(CH₃)CH₃), 0.93 (d, $J = 6.8$ Hz, 3H, CH(CH₃)CH₃) ppm. $^{13}\text{C-NMR}$ (100MHz, CDCl_3): 205.2 (s, C-2), 151.7 (d, C-4), 133.1

(s, C-3), 52.4 (s, C-1), 51.8 (s, C-5), 50.7 (t, C-8), 34.8 (t, C-6), 34.8, (d, 5-CH(CH₃)₂), 33.3 (t, C-7), 20.7 (q, 1-CH₃), 19.0, 18.4 (2q, CH-(CH₃)₂), 15.6 (q, 3-CH₃) ppm. GC/MS (EI): 192 (M⁺, 24), 177 (18), 149 (52), 136 (33), 121 (95), 110 (100), 91(46), 77 (39), 41 (41). IR (ATR) : 2959s, 2867m, 1674vs, 1446m, 1362m, 1331m, 1030s cm⁻¹.

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Example 3: 5-Isopropyl-1,3-dimethyl-bicyclo[3.2.1]octan-2-one

Prepared by hydrogenation of 5-isopropyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one.

Mixture of 2 isomers (ratio of 5/1), main isomer: ¹H-NMR (400MHz, CDCl₃): 2.46-2.39 (m, 1H), 2.13-2.06 (m, 1H), 1.88-1.43 (m, 8H), 1.29-1.26 (m, 1H), 1.16 (s, 3H, 1-CH₃), 1.11 (d, J = 7.2 Hz, 3H, 3-CH₃), 1.04-0.97 (m, 1H), 0.92 (d, J = 6.8 Hz, 5-CH(CH₃)CH₃), 0.88 (d, J = 6.8 Hz, 5-CH(CH₃)CH₃) ppm. ¹³C-NMR (100MHz, CDCl₃): 219.6 (s, C-2), 52.7 (s), 46.3 (s) 44.7 (t), 38.7 (d), 37.9 (t), 37.5 (d), 36.3 (t), 36.4 (t), 20.4 (q), 18.4 (q), 17.4 (q), 16.5 (q) ppm. GC/MS (EI): 194 (M⁺, 14), 151 (100), 133 (11), 123 (48), 93 (29), 81 (83), 69 (19), 41 (30). IR (ATR): 2958s, 2868m, 1709vs, 1458s, 1369m, 999m cm⁻¹.

15 Odor description : woody, ambery, ionone

Example 4 - 12:

The following compounds were prepared according to the synthetic procedure of
20 Example 2 from the correspondingly substituted materials and purified by chromatography where indicated.

Mixture of 5-tert-Butyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one and 1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

25 Prepared as a mixture and purified by chromatography.

a) 5-tert-Butyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one

Odor description: woody, patchouli, vetiver

¹H-NMR (400MHz, CDCl₃): 7.03 (bs, 1H, 4-H), 1.99 (ddd, J = 16 Hz, 12 Hz, 5.6 Hz, 1H, 8-H_a), 1.75 (d, J = 1.6 Hz, 3-H, 3-CH₃), 1.75-1.53 (m, 5H), 1.47-1.40 (m, 1H), 1.25 (s, 3H, 1-CH₃), 0.98 (s, 9H, 5-C(CH₃)₃) ppm. ¹³C-NMR (100MHz, CDCl₃): 204 (s, C-2), 152.6 (d, C-4), 132.3 (s, C-3), 54.2 (s), 51.9 (s), 46.9 (t, C-8), 33.5 (t), 32.9 (s, C(CH₃)₃), 30.7 (t), 25.9 (q, C(CH₃)₃), 20.7 (q, 1-CH₃), 15.5 (q, 3-CH₃) ppm. GC/MS (EI): 206 (M⁺ , 6), 191 (8), 149 (10), 135 (24), 124 (99), 110 (100) 91 (32), 77 (17), 57 (28), 41 (35). IR (ATR): 2961s, 2868m, 1673vs, 1467m, 1446m, 1365m, 1238m, 1030m, 879w cm⁻¹.

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b) 1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

Odor description: woody, patchouli

¹H-NMR (400MHz, CDCl₃): 2.19 (bs, 1H, 2-H), 1.78 (dd, *J*_{9a,9b} = 12.8 Hz, *J* = 2.0 Hz, 1H, 9-H_a), 1.76-1.50 (m, 4H, 3,4-H), 1.55 (d, *J*_{9a,9b} = 12.8 Hz, 1H, 9-H_b), 1.05 (s, 3H, 8-(CH₃)_a), 0.98 (s, 3H, 5-CH₃), 0.97 (s, 3H, 7-CH₃), 0.96 (s, 3H, 1-CH₃), 0.63 (s, 3H, 8-(CH₃)_b) ppm. ¹³C-NMR (100MHz, CDCl₃): 221.1 (s, C-6), 57.0 (s, C-7), 46.6 (d, C-2), 45.5 (s, C-8), 43.7 (s, C-5), 42.6 (t, C-9), 41.8 (s, C-1), 38.6 (t, C-4), 21.0 (q, 8-(CH₃)_a), 19.7 (2q, C-5, 8-(CH₃)_b), 18.1 (q, 1-CH₃), 10.8 (q, 7-CH₃) ppm. GC/MS (EI): 206 (M⁺, 6), 191 (10), 124 (100), 109 (27), 97 (76), 69 (22) 55 (17), 41 (31). IR (ATR): 2926m, 2862m, 1711s, 1446m, 1373m, 1004m, 761w cm⁻¹.

5-sec-Butyl-1,3-dimethyl-bicyclo[3.2.1]oct-3-en-2-one

Odor description: woody, vetiver, cedar, olibanum

Mixture of 2 isomers : ¹H-NMR (400MHz, CDCl₃): 6.86, 6.83 (2bs, 1H, 4-H), 1.95-1.51 (m, 7H), 1.75 (s, 3H, 3-CH₃), 1.40-1.32 (m, 2H), 1.23 (s, 3H, 1-CH₃), 1.00-0.90 (m, 6H) ppm. GC/MS (EI): 206 (M⁺, 8), 177 (17), 149 (41), 124 (100), 121 (82), 110 (98), 91 (42), 77 (32), 41 (43). IR (ATR): 2961s, 2865m, 1674vs, 1446s, 1364s, 1222m, 1034s cm⁻¹.

20 5-Isopropyl-3-methyl-bicyclo[3.2.1]oct-3-ene-2-one

Odor description: ambery, ciste, woody

¹H-NMR (400MHz, CDCl₃): 6.88 (bs, 1H, 4-H), 2.96 (dd, *J*_{1,7a} = 7.4 Hz, *J*_{1,8b} = 4.6 Hz, 1H, 1-H), 2.15 (m, 1H, 7-H_a), 1.92 (bd, *J*_{8a,8b} = 11.2 Hz, 1H, 8-H_a), 1.74 (d, *J* = 1.2 Hz, 3H, 3-CH₃), 1.72 (sept, *J* = 6.8 Hz, 1H, 5-CH(CH₃)₂), 1.72-1.58 (m, 2H, 6-H_a, 7-H_b), 1.52-1.45 (m, 1H, 6-H_b), 1.42 (ddd, *J*_{8b,8a} = 11.2 Hz, *J*_{8b,1} = 4.6 Hz, *J* = 2.0 Hz, 8-H_b), 1.03 (d, *J* = 6.8 Hz, 3H, 5-CH(CH₃)CH₃), 0.95 (d, *J* = 6.8 Hz, 3H, 5-CH(CH₃)CH₃) ppm. ¹³C-NMR (100MHz, CDCl₃): 204.1 (s, C-2), 152.1 (d, C-4), 133.2 (s, C-3), 51.2 (s, C-5), 50.2 (d, C-1), 43.3 (t, C-8), 34.6 (d, 5-CH(CH₃)₂), 33.8 (t, C-6), 25.5 (t, C-7), 19.0, 18.5 (2q, 5-CH(CH₃)₂), 15.2 (q, 3-CH₃) ppm. GC/MS (EI): 178 (M⁺, 49), 163 (61), 135 (50), 123 (21), 107 (100), 91 (59), 79 (46), 77 (39), 67 (23), 41 (47). IR (ATR): 2957s, 2871m, 1677vs, 1447m, 1358s, 1053m, 1018m, 918s cm⁻¹.

5,7-Diisopropyl-3-methyl-bicyclo[3.2.1]oct-3-en-2-one

Odor description: woody, elemi

Mixture of the endo/exo-isomers in a ratio of 2/1; main (endo) isomer: $^1\text{H-NMR}$ (400MHz, CDCl_3): 6.97 (bs, 1H, 4-H), 3.06 (dd, $J = 6.2, 4.4$ Hz, 1H, 1-H), 2.03-1.96 (m, 2H), 1.87 (dd, $J = 12.8, 10.4$ Hz, 1H), 1.76-1.51 (m, 3H), 1.72 (d, $J = 1.6$ Hz, 3H, 3-CH₃), 1.39-1.33 (m, 1H), 1.00 (d, $J = 6.8$ Hz, 3H), 0.96 (d, $J = 6.0$ Hz, 3H), 0.91 (d, $J = 6.8$ Hz, 3H), 0.85 (d, $J = 6.0$ Hz, 3H) ppm. $^{13}\text{C-NMR}$ (100MHz, CDCl_3): 203.0 (s, C-2), 153.9 (d, C-4), 134.0 (s, C-3), 54.4 (d, C-1), 50.2 (s, C-5), 48.5 (d, C-7), 44.4 (t, C-8), 39.1 (t, C-6), 34.7 (d), 32.4 (d), 22.2 (q), 21.7 (q), 18.6 (q), 18.3 (q), 15.0 (q, 3-CH₃) ppm. GC/MS (EI): 220 (M^+ , 17), 205 (8), 177 (22), 151 (28), 135 (32), 121 (30), 109 (100), 107 (50), 91 (47), 77 (29), 69 (35), 41 (52). IR (ATR): 2956 s, 2872m, 1673vs, 1467m, 1365s, 973m, 903m cm^{-1} .

5-Isopropyl-3,7,7-trimethyl-bicyclo[3.2.1]oct-3-en-2-one

Prepared according to Example 2 with 2,5,5-Trimethyl-6-(3-methyl-but-2-enyl)-cyclohex-2-enone as starting material.

$^1\text{H-NMR}$ (400MHz, CDCl_3): 6.88 (bs, 1H, 4-H), 2.52 (d, $J_{1,8b} = 4.4$ Hz, 1H, 1-H), 1.98 (bd, $J_{8a,8b} = 11.2$ Hz, 1H, 8-H_a), 1.80 (ddd, $J_{8b,8a} = 11.2$ Hz, $J_{8b,1} = 4.4$ Hz, $J = 2.0$ Hz, 1H, 8-H_b), 1.73 (s, 3H, 3-CH₃), 1.66 (sept., $J = 7.0$ Hz, 1H, 5-CH(CH₃)₂), 1.53 (s, 2H, 6-H), 1.19 (s, 3H, 7-(CH₃)_a), 0.97 (d, $J = 7.0$ Hz, 3H, 5-CH(CH₃)CH₃), 0.91 (d, $J = 7.0$ Hz, 3H, 5-CH(CH₃)CH₃), 0.90 (s, 3H, 7-(CH₃)_b) ppm. $^{13}\text{C-NMR}$ (100MHz, CDCl_3): 203.7 (s, C-2), 152.2 (d, C-4), 133.3 (s, C-3), 62.4 (d, C-1), 51.7 (s, C-5), 48.5 (t, C-8), 42.6 (t, C-6), 38.8 (s, C-7), 35.0 (d, 5-CH(CH₃)₂), 32.2 (q, 7-(CH₃)_a), 27.5 (q, 7-(CH₃)_b), 18.5 (q), 18.2 (q) ppm. GC/MS (EI): 206 (M^+ , 35), 191 (26), 163 (25), 135 (100), 121 (50), 107 (98), 91 (73), 77 (53), 69 (29), 55 (34), 41 (81). IR (ATR): 2957s, 2870m, 1676vs, 1466m, 1359m, 1048w, 885w cm^{-1} .

Odor description: woody, resin

1,3,5-Trimethyl-1,5,6,7,8,8a-hexahydro-1,4a-ethano-naphthalen-2-one

Odor description: woody, patchouli, vetiver, cedar

Mixture of two isomers; $^1\text{H-NMR}$ (400MHz, CDCl_3 , (1S*,4aR*,5S*,8aR*)-isomer, derived from HMQC): 6.63 (bs, 1H, 4-H), 1.77 (d, $J = 1.6$ Hz, 3H, 3-CH₃), 1.78-1.68 (m, 3H, 8-H_a, 9-H_a, 10-H_a), 1.63-1.53 (m, 2H, 9-H_b, 10-H_b), 1.54-1.47 (m, 1H, 6-H_a), 1.50-1.44 (m, 1H, 7-H_a), 1.45-1.35 (m, 1H, 5-H), 1.42-1.36 (m, 1H, 8a-H), 1.22-1.14 (m, 1H, 8-H_b), 1.16 (s, 3H, 1-CH₃), 1.08-0.94 (m, 2H, 6-H_b, 7-H_b), 1.03 (d, $J = 6.8$ Hz, 3H, 5-CH₃) ppm. $^{13}\text{C-NMR}$ (100MHz, CDCl_3): 205.0 (s, C-2), 147.2 (d, C-4), 134.7 (s, C-3),

61.3 (d, C-8a), 54.5 (s, C-1), 50.7 (s, C-4a), 41.2 (d, C-5), 34.8 (t, C-9), 33.2 (t, C-10), 31.8 (t, C-6), 25.9 (t, C-8), 21.8 (t, C-7), 18.8 (q, 1-CH₃), 16.6 (q, 5-CH₃), 15.6 (q, 3-CH₃) ppm. MS(mixture) (EI): 218 (M⁺, 96), 203 (12), 190 (7), 175 (13), 161 (7), 147 (17), 124 (100), 105 (20), 95 (58), 82 (22), 67 (8), 55 (13), 41 (24).

5

1,3,3,5,7,8,8-Heptamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

Prepared as a mixture and purified by chromatography.

Odor description: patchouli, vetiver, woody

¹H-NMR (400MHz, CDCl₃): 1.96 (bs, 1H, 2-H), 1.79 (dd, J_{9a,9b} = 13.2 Hz, J_{9a,4b} = 2.8 Hz, 1H, 9-H_a), 1.66 (d, J_{9b,9a} = 13.2 Hz, 1H, 9-H_b), 1.59 (dd, J_{4a,4b} = 13.2 Hz, J = 1.0 Hz, 1H, 4-H_a), 1.48 (dd, J_{4b,4a} = 13.2 Hz, J_{4b,9a} = 2.8 Hz, 1H, 4-H_b), 1.08 (s, 3H, 5-CH₃), 1.04 (s, 3H, 8-(CH₃)_a), 1.04 (s, 3H, 7-CH₃), 1.03 (s, 3H, 3-(CH₃)_a), 0.97 (s, 3H, 1-CH₃), 0.83 (s, 3H, 3-(CH₃)_b), 0.58 (s, 3H, 8-(CH₃)_b) ppm. ¹³C-NMR (100MHz, CDCl₃): 221.3 (s, C-6), 58.7 (d, C-2), 56.1 (s), 53.6 (t, C-4), 44.4 (s), 44.3 (s), 41.6 (s), 44.1 (t, C-9), 31.3 (s), 31.3 (2q, 3-(CH₃)_{a,b}), 21.2 (q, 8-(CH₃)_a), 20.3 (q, 5-CH₃), 19.8 (q, 1-CH₃), 18.9 (q, 8-(CH₃)_b), 13.4 (q, 7-CH₃) ppm. GC/MS (EI): 234 (M⁺, 28), 219 (20), 163 (15), 152 (43), 137 (62), 121 (49), 97 (199), 83 (18), 69 (25), 57 (72), 41 (69). IR (ATR): 2959m, 2919m, 2865m, 1712s, 1452m, 1374m, 1005m, 951m, 886w cm⁻¹.

20 3,3,5,7,8,8-Hexamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

Prepared as a mixture and purified by chromatography.

Odor description: ambery, woody, pine resin, Grisalva

¹H-NMR (400MHz, CDCl₃): 2.32 (t, J = 6.0 Hz, 1H, 1-H), 2.21 (d, J = 6.0 Hz, 1H, 2-H), 1.90 (dd, J = 13.2 Hz, 6.0 Hz, 1H, 9-H_a), 1.74 (dd, J = 13.2 Hz, 2.6 Hz, 1H), 1.57 (d, J = 13.2 Hz, 1-H), 1.48 (dd, J = 13.2, 2.6 Hz, 1H), 1.17 (s, 3H), 1.04 (s, 3H), 1.00 (s, 3H), 0.97 (s, 3H), 0.84 (s, 3H), 0.64 (s, 3H) ppm. ¹³C-NMR (100MHz, CDCl₃): 220.9 (s), 57.3 (s), 53.3 (t), 52.6 (d), 44.0 (s), 42.3 (s), 39.6 (d), 33.4 (t), 30.9 (s), 30.5 (q), 30.3 (q), 23.9 (q), 20.1 (q), 20.0 (q), 13.4 (q) ppm. GC/MS (EI): 220 (M⁺, 6), 205 (5), 164 (64), 152 (37), 137 (199), 123 (19), 91 (14), 69 (26), 55 (17), 41 (46). IR (ATR): 2956m, 2924m, 2866w, 1711s, 1451m, 1373m, 1012m, 956m, cm⁻¹.

Mixture of 3,3,5,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one and 1-Isopropyl-3,3,5-trimethyl-tricyclo[3.2.1.0^{2,7}]octan-6-one

Prepared as a mixture and purified by chromatography.

35 a) 3,3,5,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

Odor description: woody, patchouli, cedar, camphoraceous

¹H-NMR (400MHz, CDCl₃): 2.61 (t, J = 5.0 Hz, 1H, 7-H), 2.46 (bt, J = 5.6 Hz, 1H, 2-H), 2.34 (bq, J = 5.6 Hz, 1H, 1-H), 1.92 (dd, J_{9a,9b} = 13.2 Hz, J_{9a,1} = 5.6 Hz, 1H, 9-H_a), 1.73 (J_{9b,9a} = 13.2 Hz, J = 2.8 Hz, 1H, 9-H_b), 1.58 (d, J_{4a,4b} = 13.6 Hz, 1H, 4-H_a), 1.49 (dd, J_{4b,4a} = 13.6 Hz, J = 2.8 Hz, 1H, 4-H_b), 1.32 (s, 3H, 8-(CH₃)_a), 1.02 (s, 3H, 3-(CH₃)_a), 0.97 (s, 3H, 5-CH₃), 0.82 (s, 3H, 3-(CH₃)_b), 0.75 (s, 3H, 8-(CH₃)_b) ppm. ¹³C-NMR (100MHz, d₆-acetone): 219.0 (s, C-6), 57.6 (d, C-7), 53.2 (t, C-4), 47.2 (d, C-2), 44.3 (s, C-3), 40.7 (d, C-1), 40.6 (s, C-5), 33.6 (t, C-9), 29.9 (q, 3-(CH₃)_a), 29.8 (q, 3-(CH₃)_b), 29.8 (s, C-8), 27.1 (q, 8-(CH₃)_a), 21.6 (q, 8-(CH₃)_b), 19.8 (q, 5-CH₃) ppm. GC/MS (EI): 206 (M⁺, 17), 191, (15), 150 (29), 138 (145), 123 (64), 107 (48), 83 (100), 55 (29), 41 (48). IR (ATR): 2953s, 2866m, 1716vs, 1459m, 1373m, 1105m, 1002w, 931w, 898w cm⁻¹.

b) 1-Isopropyl-3,3,5-trimethyl-tricyclo[3.2.1.0^{2,7}]octan-6-one

Odor description: woody, cedar, veriver, fruity, patchouli

¹H-NMR (400MHz, C₆D₆): 1.62 (d, J = 8.3 Hz, 1H, 7-H), 1.59 (dd, J_{8a,8b} = 11.2 Hz, J = 2.4 Hz, 1H, 8-H_a), 1.52 (d, J_{8b,8a} = 11.2 Hz, 8-H_b), 1.45 (dd, J_{4a,4b} = 13.6 Hz, J = 2.2 Hz, 1H, 4-H_a), 1.26 (d, J_{4b,4a} = 13.6 Hz, 1H, 4-H_b), 1.21-1.11 (m, 2H, 2-H, 1-CH(CH₃)₂), 1.01 (s, 3H, 5-CH₃), 0.99 (s, 3H, 3-(CH₃)_a), 0.96 (s, 3H, 3-(CH₃)_b), 0.83 (d, J = 6.8 Hz, 3H, CH(CH₃)_a(CH₃)_b), 0.80 (d, J = 6.8 Hz, 3H, CH(CH₃)_a(CH₃)_b) ppm. ¹³C-NMR (100MHz, C₆D₆): 212.6 (s, C-6), 52.2 (t, C-4), 46.0 (d, C-2), 42.7 (s, C-5), 40.2 (s, C-1), 34.3 (t, C-8), 34.1 (d, C-7), 32.0 (2q, 3-(CH₃)_{a,b}), 31.9 (d, 1-CH(CH₃)₂), 29.2 (s, C-3), 18.9 (q, 5-CH₃), 18.8 (q, 1-CH(CH₃)_a(CH₃)_b), 18.7 (q, 1-CH(CH₃)_a(CH₃)_b) ppm. GC/MS (EI): 206 (M⁺, 41), 191 (37), 151 (15), 135 (36), 109 (100), 91 (38), 77 (24), 55 (21), 41 (43). IR (ATR): 2957m, 2926m, 2867m, 1725s, 1462m, 1317m, 1171m, 917m, 866 m, 834m cm⁻¹.

Example 13: 5,7,8,8-Tetramethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one

A solution of 2,6-dimethyl-6-(3-methyl-but-2-enyl)-cyclohex-2-enone (10.0g, 52.1 mmol) in methanol (250 ml) was irradiated using a Hg-lamp during 3h. The solvent was evaporated in vacuo and the residue distilled in a Kugelrohr oven to yield 5.0 g of a colorless oil.

Odor description: patchouli, woody, camporaceous

¹H-NMR (400MHz, CDCl₃): 2.54 (m, 1H, 2-H), 2.23 (t, J = 5.8 Hz, 1H, 1-H), 1.88 (dd, J_{9a,9b} = 12.8 Hz, J = 5.6 Hz, 1H, 9-H_a), 1.78 (d, J_{9b,9a} = 12.8 Hz, 1H, 9-H_b), 1.88-1.52 (m, 4H, 3,4-H), 1.17 (s, 3H, 8-(CH₃)_a), 1.00 (s, 3H, 5-CH₃), 0.99 (s, 3H, 7-CH₃), 0.66 (s, 3H, 8-(CH₃)_b) ppm. ¹³C-NMR (100MHz, C₆D₆): 217.6 (s, C-6), 58.1 (s, C-7), 42.7 (2s, C-5,8), 41.3 (d, C-1), 40.7 (d, C-2), 38.1 (t, C-4), 34.4 (t, C-9), 23.5 (q, 8-(CH₃)_a), 20.4 (q, 8-(CH₃)_b), 20.2 (q, 5-CH₃), 17.5 (t, C-3), 11.1 (s, 7-CH₃) ppm. GC/MS (EI): 192 (M⁺, 14), 177 (12), 149 (8), 124 (100), 109 (48), 93 (15), 82 (20), 69 (34), 53 (18), 41 (52). IR (ATR): 2923m, 2863m, 1710s, 1448m, 1375m, 1068m, 1020m, 1000m, 790w cm⁻¹.

10 **Example 14: 5,6,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-ol**
 Prepared from 5,7,8,8-tetramethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one by reaction with methyl magnesium chloride.
 Odor description: patchouli, woody, camphoraceous
¹H-NMR (400MHz, C₆D₆): 2.23 (dd, J_{9a,9b} = 13.2 Hz, J_{9a,4a} = 3.2 Hz, 1H, 9-H_a), 2.12-2.09 (m, 1H, 2-H), 1.95 (dd, J_{1,9b} = 6.8Hz, J_{1,2} = 6.0 Hz, 1H, 1-H), 1.62-1.49 (m, 3H, 4-H_a, 3-H_{a,b}), 1.43 (dd, J_{9b,a} = 13.2 Hz, J_{9b,1} = 6.8 Hz, 1H, 9-H_b), 1.37 (s, 3H, 8-(CH₃)_a), 1.26-1.18 (m, 1H, 4-H_b), 1.21 (s, 3H, 8-(CH₃)_b), 1.04 (s, 3H, 6-CH₃), 0.97 (s, 3H, 5-CH₃), 0.94 (s, 3H, 7-CH₃) ppm. ¹³C-NMR (100MHz, C₆D₆): 79.6 (s, C-6), 50.4 (s, C-7), 42.1 (s, C-8), 41.7 (d, C-1), 38.7 (d, C-2), 36.9 (s, C-5), 36.5 (t, C-9), 35.8 (t, C-4), 27.9 (q, 8-(CH₃)_a), 24.9 (q, 6-CH₃), 21.6 (q, 8-(CH₃)_b), 20.9 (q, 5-CH₃), 18.0 (t, C-3), 12.8 (q, 7-CH₃) ppm. GC/MS (EI): 208 (M⁺, 1), 190 (22), 175 (28), 162 (9), 147 (48), 121 (73), 98 (59), 83 (37), 69 (19), 55 (31), 43 (100), 41 (43). IR (ATR): 3502br., 2947vs, 2902vs, 2869s, 1457s, 1371s, 1207m, 1110s, 1072s, 1045s, 922vs cm⁻¹.

25 **Example 15:**

A perfume for a shower gel with a woody-floral character

	parts per weight
Cedryl acetate	5
30 Citronellyl acetate	2
Linalyl acetate	20
Agrumex	20
Pheyl ethyl alcohol	40
Amyl cinnamyl aldehyde	140
35 Ambrettolide	5

	Ambrofix	4
	Bois Cedre ess. Virginie	20
	Bois Gaiac ess.	10
	Damascenone (10% in DPG)	6
5	Dipropylene glycol	10
	Eucalyptus ess.	24
	Galaxolide 50 BB	381
	Hedione	80
	Javanol	2
10	Lilial	30
	Linalool synt.	20
	Mandarine ess.	30
	Moxalone	40
	N 112	1
15	Okoumal	5
	Orange terpenes dist.	60
	Rose abs. Turquie	2
	Rose artess abs.	10
	Rose oxide (10% in DPG)	5
20	Super muguet	10
	Vanilline (10% in DPG)	8
	1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0 ^{2,7}]nonan-6-one	10

		1000

25

In this composition 1,5,7,8,8-Pentamethyl-tricyclo[3.3.1.0^{2,7}]nonan-6-one enhances and harmonizes the woody part. It underlines the patchouli aspect but gives also a new modern woody character. The compound blends well with the floral part of the perfume and provides volume without giving a heavy impression.

30